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XIX.—*On the* Polytremata (*Foraminifera*), *especially with reference to their Mythical Hybrid Nature.* By H. J. Carter, F.R.S. &c.

[Plate XIII.]

Synonymy of Polytrema miniaceum.

Millepora miniacea, Linn. 1788, Syst. Naturæ, ed. Gmel. vi. p. 3784; Esper, 1797, vol. i. tab. xvii.
Millepora rubra, Lamk. 1816, Anim. sans Vert. vol. ii. p. 202.
Polytrema corallina, Risso, 1826, Hist. Nat. Europ. mérid. vol. v. p. 340. no. 91.
Polytrema miniaceum, De Blainville, 1834, Man. d'Actin. p. 410, and p. 673, pl. lxix. fig. 4.

Polytrema miniaceum, De Blainville, 1834.
Pl. XIII. figs. 1–6.

The true nature and position of this organism in the animal kingdom was first recognized and pointed out by the illustrious Dujardin, who, in 1841, placed it in his third family of Rhizopoda (Hist. Nat. des Zoophytes Infusoires, p. 259)—conjecturally, it is true (but such is at once the modesty and sagacity of this author that his conjectures may almost be taken as facts); while its pseudopodial extensions are illustrated by those of his *Vorticialis strigilata* = *Polystomella* (*op. cit.* pl. i. fig. 15). I need hardly add that the genera of his Rhizopoda are respectively *Arcella*, *Difflugia*, *Trinema*, *Euglypha*, *Gromia*, *Miliola*, *Cristellaria*, and *Vorticialis*, to which we may now add not only the whole of the Foraminifera, but also Ehrenberg's Polycystina, now called Radiolaria.

Ever since 1858, when the late Dr. J. E. Gray published a paper entitled "On *Carpenteria* and *Dujardinia*, two genera of a new Form of Polyzoa with attached Multilocular Shells filled with Sponge, apparently intermediate between Rhizopoda and Porifera" (Proc. Zool. Soc. part xxvi. 1858, pp. 266–271), I have been ever doubtful of this supposed fact being any thing more than *in appearance*, as the title just mentioned indicates, while the author (my dear old friend, alas! only "dear" now to memory) entirely repudiated the notion during the latter part of his life.

Subsequently, according to the late Prof. Max Schultze, to whose paper on *Polytrema* I shall often have to allude ('Annals,' 1863, vol. xii. p. 411, translated by W. S. Dallas, F.L.S., from Wiegmann's 'Archiv,' 1863, p. 81), "At Dr. Gray's request, Carpenter then more fully investigated the structures arranged in the genus *Carpenteria*, and published a memoir in the 'Philosophical Transactions' for 1860 (vol. cl. p. 564 *et seq.*), in which he also mentions the *Polytrema miniaceum* of De Blainville as an organism which possesses a foraminiferous structure of the calcareous shell, and is most nearly allied to the genus *Tinoporus* (p. 561). Carpenter found the sponge-spicules constantly in the chambers of the Polythalamian named after him, and intimates his adhesion to Gray's view that it is a transition form between Foraminifera and Sponges."

I have not access to this "memoir;" but as Carpenter's 'Introduction to the Study of the Foraminifera' (Ray Soc. Publ. 1862) was published *after* it, we must take the more cautious phraseology used there respecting the nature of *Carpenteria*, which is as follows (p. 189), viz. "We seem fully justified in regarding it [*Carpenteria*] as a very interesting link of connexion between Foraminifera and the Sponges." Thus Carpenter was never very hearty in his assertion; for the word "seem" indicates that he had still some misgiving as to the fact.

Prof. Max Schultze, however, after having carefully gone into the arguments for and against the question, concludes his article with the following paragraph:—

"For this reason I cannot regard the conditions in *Carpenteria* otherwise than as in *Polytrema*, and therefore believe that the boundary between Polythalamia and Sponges, which has hitherto been considered as a very sharp line, must still be maintained in all its integrity" (*l. c.* p. 418).

Up to his writing this Max Schultze had not seen Carpenter's 'Introduction;' but after he had done so he added a

"Supplement" (*l. c.* p. 419), in which the opinion just stated was not retracted, and the following inserted respecting the separation of *Carpenteria* from *Polytrema*, viz.:—"Carpenter had no inducement to discuss the question whether *Polytrema* produces spicules and is thus allied to *Carpenteria*, as his specimens contained *no spicules in their interior*. Nevertheless he mentions having seen specimens with the surface entirely covered with a parasitic sponge, the spicules of which, however, penetrated scarcely if at all into the interior of the chambers. By this means Carpenter establishes a sharp distinction between *Polytrema* and *Carpenteria*."

If, then, hereafter it shall appear that the presence of spicules in *Polytrema* is a common although it may not be a constant occurrence, I might say with Prof. Max Schultze (p. 419), "Perhaps my observations on *Polytrema* which indicate the remarkable affinity between that genus and *Carpenteria* may serve to shake Carpenter's faith in his opinion."

In 1870 Dr. Carpenter, with his wonted generosity, gave me some specimens of *Polytrema*, which, after examination, led me to the views expressed in the 'Annals' of that year (vol. v. p. 391), viz. that under the circumstances it was not strange "that the spicules which to-day are matted among its [*Polytrema*'s] pseudopodia, on its surface, should in a few days after be found in the interior of its calcareous structure."

These "views" I can now substantiate from the possession of specimens which present the features about to be noticed in the following description of *Polytrema miniaceum*.

POLYTREMA, gen., Risso, 1826.

Test fixed, solitary or grouped. Composition calcareous. Structure cancellous, presenting a polygonally divided surface with foraminated interstices, and internal cavities which communicate with the exterior by one or more apertures. Cavities often containing few or many siliceous spicules entire and fragmentary, derived from different kinds of sponges.

Polytrema miniaceum, sp., De Blainville, 1834. Pl. XIII. figs. 1–6.

Test fixed, calcareous, solitary. General form massive, rising from an irregularly circular or lobed, root-like, expanded base, passing into a round stem, which soon divides into a head composed of a variable number of expanded short branches, that speedily terminate in more or less compressed divisions, each of which ends in an irregular row of subsquare apertures, respectively marginated by an inflated round rim extended upwards on one or two sides opposite into the form of a lip or lips, so as to present *en profil* a serrated or cock's-comb appearance (fig. 6). Colour coral-red or pink. Surface uniformly even, except where interrupted by the branches, whose apertures (fig. 6, *c c c*) in many instances are more or less filled with sponge-spicules entire and fragmentary, together with grains of sand and other minute objects, forming a mass which is continuous with strings of the same material extended in an irregular network between the apertures generally (fig. 6, *m m m*) ; which network is frequently intersected by the most delicate, straight, cobweb-like threads, the remains of dried pseudopodia (fig. 6, *s s*). Presenting a variety of surface-patterns according with the age of the structure, locally and generally, viz. :—at first, or in the earliest period, a foraminated groundwork in which there may be a few unforaminated dimples or depressions (fig. 6, *g g g*) ; then the dimples may be united by limited, branched, linear, unforaminated areæ, somewhat narrower than the foraminated part, so as often to present together a submeandriniform appearance (fig. 6, *h h*) ; or the dimples may be expanded into circular foraminated areæ, surrounded respectively by an unforaminated ring, the whole being set in a foraminated groundwork (fig. 6, *i*) ; or, lastly, over the thickest parts of the fully developed test, the foraminated groundwork may give place to a subhexagonal or polygonal unforaminated reticulation, whose interstices *only* are foraminated (fig. 6, *k*). Internal structure cancellous in appearance, but originally consisting of subconcentric (imbricative or eccentric) foraminated laminæ supported on *detached hollow* pillars, whose positions respectively are for the most part indicated by the " dimples " and circular depressions externally, each lamina thus forming a continuous cavity between itself and the next following inwards, like the roof and pillars of a crypt (fig. 3). Presenting, in horizontal sections at different distances from the base, subconcentric layers diminishing in number towards the truncated neck ; and in a vertical section, the same in a conical form, interrupted above at the truncation of the neck. Finally (*i. e.* in the old state) losing the foraminated portion of the lami na except on the surface ; the subhexagonal network alone remaining internally, which, together with the *hollow* pillars now become solid, forms a continuous netted mass or labyrinthic reticulation, in which it becomes difficult, for want of the foramination, to trace the subconcentric layers inside the surface-one (fig. 6, *e*, *t t*). Cavernous dilatations or cavities of the internal structure (fig. 6, *v v v*), in continuation with each other, exist about the axis of the specimen, which, arising in the confines of the test, finally communicate with the apertures at the ends of the branches; hence the masses of spicules and grains of sand which they often contain (fig. 6, *v v v*) can be easily explained; together with other spicules, which, having become incorporated during growth, more or less traverse the test generally—the whole of the structure internally being lined with sarcode, which, according to Max Schultze (who had recent specimens to deal with, *l. c.* p. 411), is in the form of chambers opening into each other by stolon-like constrictions, through which they not only intercommunicate but are successively produced ('Annals,' 1863, vol. xii. pl. vii. figs. 4–8). Still, although it is easy to see how these chambers communicate with the cavernous dilatations or cavities in the midst of the reticulated structure in the *old* specimens, where the sarcodic lining has become thickened and dried into a chitinous layer, it is not so easy to see how it takes place in the younger specimens, where the foraminated interstices have not become absorbed and the subconcentric layers (fig. 3, *a a a*) of which the test is formed apparently permit of no other communication between their cavities. Size of largest specimens (which, for the most part, have their branches broken off) 3-24ths inch in diameter and 2-24ths inch high.

Hab. Marine, on solid objects, chiefly stony coral.

Loc. Mediterranean; Red Sea; West Indies; Mauritius; Torres Straits; Australia; Polynesia.

Obs. There are two forms in which *Polytrema miniaceum* is found, viz. massive and branched; but the former appears to me to differ from the latter merely in the branches having been broken off, in which the remaining portions thus truncated have provided themselves with the form of apertures above mentioned (fig. 6, *b b*). The branches, which seldom undergo a second division beyond a divided grouping of the apertures at their extremities (fig. 6, *a a a*), vary in number from a few to a great many, in which case the specimen sometimes presents a head of branches almost as closely approximated as those of a cauliflower.

Following the mode of growth in a specimen of *Polytrema miniaceum* not more than 1-80th inch in diameter at the base, and about 1-83rd inch high (fig. 4), it may be observed at this period to present a circular patch or base of cancellated structure (fig. 4, *a*), rising up in the centre into a short cylindrical process (fig. 4, *b*), the whole of which is thickly though minutely foraminated on the surface, and more or less divided and dimpled by an unforaminated network of lines, which give to the interstices shapes varying from circular to submeandriniform, simple or branched; while internally this structure is supported on processes which rest on a thin chitinous layer that adheres to the object on which the specimen may be growing. Thus constituted, the foraminated surface and cancellated structure extend upwards into the short cylindrical process mentioned, which, presenting a single tubular aperture with round inflated rim, terminates the young *Polytrema* in this direction (fig. 4, *d*). But as the upper part of this cylindrical process consists of a single thin foraminated layer of a tubular form, it is very delicate, and is thus often broken off down to where the interior begins to pass into the cancellated structure, and thus becomes stronger (fig. 4, *e*). Here we may observe, on looking endwise into the *truncated* end, that the cylindrical process is divided into three or more portions (fig. 5), each of which is successively larger than the foregoing one; so that the last (which nearly embraces all the rest, and thus occupies two thirds of the circle on one side, while the three others occupy the other third) completes the circle as it grows above them into the delicate foraminated tubular layer, which ends in the single aperture above mentioned. It is thus in the "*truncated* end" that we seem to be able to trace a resemblance to the spiral growth and successive enlargement of the primary chambers manifested in the Foraminifera generally, more especially in those which belong to the discoid type. As the young *Polytrema* increases in size, new circumferential layers are added until a mass is produced which passes into a thick round stem with several branches (fig. 1). Hence the original *single* axis becomes divided into as many as there are branches, each of which is but a repetition of the original one in point of development.

Although the "truncated end" of the cylindrical process (fig. 5) in the young *Polytrema* seems, by its multilocular structure and arrangement, to indicate a spiral mode of growth, I have never been able to recognize a spiral arrangement of the lines presented by the base of a *Polytrema*—although on one occasion a *subsequent* concentric arrangement of these lines seemed to indicate a spiral beginning, as such an arrangement often follows a spiral one in many specimens of the discoid Foraminifera. However, as this did occur, although only in one instance, which has been dry-mounted, I will now briefly describe it.

The specimen, a small branched one, had been overgrown by the horny fibre of *Chalina oculata* (sponge), through the former having previously attached itself to the hard object subsequently selected by the latter. Consequently when the sponge (an insignificant fragment picked up on one of the

"Ebon Islands, Oceania") was examined, it was found to have torn off the *Polytrema* entire from the hard object, thus protecting its branched head, while the disk of its base is equally well preserved; I have been able to view the latter through a 1-inch object-glass and make the accompanying delineation. The whole disk, which is circular, measures about 5-48ths inch in diameter, of which the figure represents about 2-48ths inch of the centre (fig. 2). This portion, which only in its outer part bears indication of the cyclical arrangement of chambers, not an uncommon sequel (as before stated) to the spiral commencement common to and most obvious in the discoid Foraminifera, presents a *confused* centre (fig. 2, *a*), beyond which come three circular rows of radiating lines (fig. 2, *b*), which, from their quadrilateral interspaces, would, in *Orbitoides dispansa* &c., represent as many chambers of the central plane ('Annals,' 1861, vol. viii. pl. xvi. fig. 1, *l*), but here are covered in by a basal chitinous layer of unforaminated sarcode, which was the bond of union between the *Polytrema* and the hard object on which it grew, and which, on having been partly removed over *one* row (fig. 2, *c*), brings into view a continuous, apparently circular, ring-like cavity with foraminated roof sloping in towards the centre of the specimen; so that the resemblance to the chambers of the central plane in *Orbitoides dispansa* does not appear to go beyond the "three circular rows of radiating lines with quadrilateral interspaces."

Leaving this unique specimen, which only illustrates this point, and going to the superstructures of *Polytrema* generally, we observe that its resemblance to *Orbitoides dispansa* is no longer traceable; for when we come to the continuous conical solid pillars of shell-substance, whose large ends are so conspicuous on the surface of the latter, and are the same in *Tinoporus baculatus* and *Conulites Cooki*, Carter, = *Patellina* (Carpenter), it will be found that there *are* none. The unforaminated as well as the foraminated dimples in the foraminated portion of the surface of *Polytrema* (fig. 6, *g*, *i*) only indicate, as before mentioned, hollow structures which in the early part of life support the foraminated layers (fig. 3). Hence Dr. Carpenter's "aggregation of calcareous substance into solid pillars (*b b*) exactly resembling those which have been seen in *T. baculatus* and in *Patellina Cooki*" (Introduction, p. 286) is imaginary. The unforaminated dimples on the surface of *Polytrema* which most resemble the ends of the "solid pillars" alluded to are the ends of short, interrupted, cylindrical pillars, in some parts foraminated at both ends, which, it is true, give support to the spans or arches of the undulating foraminated circumferential layers, but rest on the convexities of the latter as often as on any other part—that is, so irregularly as to make it impossible to connect them into a continued line of support (fig. 3, *a*, *b*) even *like* the "solid pillars" of *Orbitoides* &c., which are not only solid but continuous from the circumference to the centre of the test. Thus the structure of *Polytrema miniaceum* is wholly cancellous, and without other support than that which the peculiar arrangement and form of the foraminated layers and their hollow pillars give to the whole mass. It is, in fact, just what Dr. Carpenter has described in "*Parkeria*" without the "labyrinthic structure" (Phil. Trans. 1870, vol. clvii. pt. 2, p. 721); while if the "parallel columnar or tubular processes springing from the internal surface of the spiral lamina" of *Loftusia* (*ib.* p. 745, pl. 79. figs. 1 & 2) are to be considered equal to the foraminated subconcentric walls of *Polytrema miniaceum*, the radial columns of the latter, whose cavities are continuous with this foraminated structure, would appear to be almost identical with those of *Loftusia*.

Be this as it may, in the early part of the life of *Polytrema miniaceum* (that is, during the time the test is being constructed), the object appears to be to combine the greatest amount of strength with the least quantity of material, and thus the radial processes are hollow; while only in the after part of the life of the *Polytrema* they become consolidated, and the tubulation of the concentric layers obliterated, if not removed altogether, *except on the surface*, as before stated.

I also now observe, in a mounted thin horizontal section of *Alveolina meandrina* which I retained when the rest of the specimens of this fossil were given to the Geological Society of London in 1863 (originally coming from the valley of Kelat, not very far from the Bakhtiyari Mountains, in Persia, where the late Mr. Loftus found "*Loftusia*"), that the former presents a cavernous or cancellated structure almost identical with that of "*Loftusia*" and *Polytrema miniaceum*, which structure, in my short description of *Alveolina meandrina* ('Annals,' 1861, vol. viii. p. 381, pl. xvii. fig. 4, *f*), I had erroneously regarded and represented (fig. 4, *f*, 2 & 3) as the "canal-system" in this species, while it now proves to be what is above stated and no "canal-system" at all, as the latter, if there had been any, would be recognized by its tubular form *within* the cavernous structure. My "marginal reticulation" (fig. 4, *f*, 2) and "vertical canals" (fig. 4, *f*, 3) would thus be analogous to corresponding parts in *Polytrema miniaceum*, *Parkeria*, and *Loftusia*, the pillars being mere supports and not indications of the limits of the chambers, which are otherwise marked by the successive curving inwards of the subconcentric or excentric foraminated layers upon each other, in *Polytrema*, as before stated. There is, however, no appearance of "sand-grains" in this section of the structure of *Alveolina meandrina*, which is so thin as to admit of being examined by a ¼-inch object-glass and transmitted light, when even the tubulation of the spiral or foraminated layers is visible. Of this species I stated (p. 328 *l. c.*), it is "so different from any other existing description, that at first sight it seems doubtful whether it should not form the type of a new genus."

Another point which distinguishes *Polytrema* from almost all the other chambered Foraminifera is the presence of the aperture on the summit of the test, singly in the embryonic form (Pl. XIII. fig. 4, *d*) or in plurality in the full-grown individual (fig. 6, *c c c*). This may reasonably be assumed to commence in the central cell of the disk which forms the base of the embryonic test (fig. 4), and then only has its analogy in *Squamulina scopula*, which appears to arise from the central cell of the submultilocular Rotaline test that forms its foot or means of attachment to some submarine body ('Annals,' 1870, vol. v. pl. iv. fig. 3, *k*). Of course the one-chambered or lageniform Foraminifera do not enter into this category.

Still another point is the branching of the summit (Pl. XIII. fig. 1), which finds its analogue in *Squamulina ramosa* alone, although in *S. ramosa* the branching, instead of stopping at the first degree, may be continued on to the third ('Annals,' 1870, vol. vi. p. 347).

Lastly, we come to the canal-system, of which there seems to be an entire absence. Dr. Carpenter does not mention it; and I have not seen it. There is a fine polygonal linear network to be seen in the centre of the unforaminated subhexagonal reticulation with foraminated interstices which characterizes the surface of an older form of *Polytrema miniaceum*; but this appears to be only a single straight linear canal, about 1-12000th inch in diameter (fig. 6, *l*), which originally communicated with the hollow pillars now, in the older development, become solidified. It is well represented in Max Schultze's figure of an "Acervuline *Planorbulina*" in Dr. Carpenter's 'Introduction' (pl. xiii. fig. 1), and might have been connected with the original formation of the subhexagonal reticulation, which does not appear in the newly developed structure (fig. 6, *f f f*); and therefore, whatever this tubular network may be, *it does not come into existence until the former is developed.*

Directing our attention to the internal structure, we find that the cancellated test is lined by a proper membrane (if a structureless sarcodic layer becoming brown and glue- or gum-like when dry may be so termed), which abuts upon the foramina of the walls and, according to Max Schultze as before stated, is divided into chambers which open into each other by two or more stolon-like constrictions, through which these chambers not only communicate with each other but were successively produced, finally opening into the cavernous dilatations which are in direct continuation with the surface through the apertures at the ends of the branches; besides which, accident seems to form openings in the old test here and there, as it does in the chamber of *Operculina*, through destruction of the foraminated interspaces, which thus also lead directly into the interior.

It can now be understood how the spicules and calcareous grains of sand not only find their way into the cavernous dilatations, and occasionally into the sarcodic chambers themselves, but also become imbedded in the cancellated structure during its exogenous growth, and thus are found to transfix the test generally, after the same manner as small Foraminifera were found by Mr. H. B. Brady to have become accidentally imbedded in *Loftusia* (*loc. cit.* pp. 749 & 750).

For want of fit specimens to demonstrate this, Max Schultze was obliged to have recourse to lengthy arguments beginning with the following premises, viz. :—" Either the siliceous spicules have penetrated accidentally, or they have been taken in as food, or, lastly, they belong to a parasitic sponge" (*loc. cit.* p. 416), finally concluding that the presence of the sponge-spicules in *Polytrema* might be owing to its being infested by a parasitic sponge, and that transition forms between Foraminifera and Porifera have but little probability (*ib.* p. 417).

But now that we have "fit specimens," such arguments are not necessary; for the facts can be told in a few words, viz. that sponge-spicules and minute sand-grains, respectively siliceous and calcareous, together with a heterogeneous assemblage of the tests of minute organisms generally, both entire and fragmentary, may be observed to form dried thread-like filaments more or less netted together (fig. 6, *m m m*), and traceable into the apertures of the *Polytrema* (fig. 6, *c c c*), after which the same kind of material may be found further down in the cavernous dilatations of the test (fig. 6, *e*, *v v v*), leaving no kind of doubt that the dried thread-like filaments were originally soft pseudopodial extensions of the internal sarcode, which, coming into contact with the minute material mentioned, had thus agglutinated and drawn it into the *Polytrema*.

Although the sarcodic substance cannot be well distinguished in these thread-like filaments, it can be seen with an inch object-glass and reflected light in the form of delicate cobweb-like extensions, stretching across them from point to point, in connexion with the apertures of the *Polytrema* (fig. 6, *s s*). How these delicate filaments could have survived the boisterous waves of a rocky shore like that of the Mauritius it is almost impossible to conceive, unless they were the dying efforts of the foraminifer (whose sarcode has great vitality) after the coral detritus adhering to the sponge on which it was found had been finally thrown up upon the beach beyond all further influence of the sea; for such was the character of the sponge which Col. Pike, U.S. Consul at the Mauritius, sent to Dr. Dickie, and the latter to myself, on which I found the little specimen presenting this phenomenon, which specimen is now dry-mounted in a closed cell for preservation and further observation.

All this may be very clear; but still there is Max Schultze's question whether the materials above mentioned got into the *Polytrema* "accidentally or have been taken in as food."

In the first place, it is evident that the calcareous test of *Polytrema* requires calcareous material for its structure; and so far the calcareous element may be disposed of. But what becomes of the siliceous element in the sponge-spicules?

Here it is necessary to remember that siliceous sponge-spicules are not purely mineral and crystalline like grains of quartz-sand, but are a combination of silex and organic matter. Hence, if it can be shown that any organism has the power of extracting this organic matter for nutriment, it may be assumed that the *Polytrema* also may possess this power.

That siliceous sponge-spicules are destroyed by an organism for this purpose I have shown ('Annals,' 1873, vol. xii. p. 457, pl. xvi. figs. 8 & 9); and that there is a cell which can penetrate the walls of the spicule as *Chytridium* does the cell-wall of *Spirogyra* &c. is thus proved.

Still, as regards *Polytrema*, I do not think that this can be the case (certainly not with those spicules which are found imbedded in and transfixing the test generally), but that the masses of spicules (which are chiefly fragmentary) in the cavernous cavities (fig. 6, *v v v*) may be *ingesta*, which by accident have been drawn in by the pseudopodia, and have accumulated there like the hairs forming the "hair ball" of the ox's stomach, or the beaks and other *ingesta* of Cephalopoda, which, under the name of "ambergris," form a similar accumulation in some part of the alimentary canal of the sperm-whale.

The presence of a sponge, too, growing over the surface of a *Polytrema* is easily explained by the fact that most sponges overgrow every stationary object with which they come into contact; and as all kinds of sponges may do this, so the *Polytrema* may at one time be overgrown by one kind of sponge and at another by another kind, this being, in the matter of difference, purely accidental. But there is only one kind of sponges that can become really parasitic, viz. the Clionida or boring sponges; and these do not grow *upon* but *in* their host, and thus *in* the test of *Polytrema*. Of this I have but one instance in *Polytrema*, although it is common enough elsewhere; and here the usual cavities in the test of the host, together with their circular fenestral openings on the surface, have, by the position and regular arrangement of the spicules, which are *always entire*, at once pointed out their true nature, in contradistinction to the spiculiferous accumulations within the natural cavities of the *Polytrema*. As further means of distinction, it may be added that the *pointed* ends of the spicules in sponges are *always* directed *outwards*, and the pin-like spicules of a *Cliona*, which are chiefly confined to a bristling coronal arrangement filling the circular fenestral apertures which it has formed on the surface of its host, are arranged after this manner; 2nd, the spicules are entire and *regularly* arranged; 3rd, they are for the most part unaccompanied by grains of sand and other foreign objects. On the other hand, in *Polytrema* the pointed ends of the spicules are sometimes outwards and sometimes inwards (fig. 6, *n n* &c.), there are more fragments than entire forms (fig 6), and the whole is confusedly arranged and mixed up together with sand-grains and a variety of minute foreign objects (fig. 6, *m m m*).

Then, again, the spicules in *Polytrema*, besides being for the most part fragmentary, are of different forms, although chiefly linear, as the furcate and radiated forms are more difficult of introduction. The latter seems to be proved not only by their absence generally in the interior, but by their appearing sometimes on the surface of the *Polytrema* with one arm fixed in the aperture and the others outside (fig. 6, *p*).

Again, the spicules may belong to different sponges. In one mounted rounded embryonic specimen of *Polytrema* from the Mauritius, whose rounded form had been occasioned by the summit having been broken off, there are several hamates and anchorates together with a linear spicule, all evidently derived from *Halichondria incrustans*; while in the embryonic specimen figured, in which a portion of the side of the summit only is broken away, three linear spicules may be observed, one of which is pin-like and therefore not belonging to the sponge mentioned (fig. 4), and so on. In another mounted but older structure a fusiform, nodose, calcareous spicule, of a deep purple colour, from a *Gorgonia* projects from one of the apertures (fig. 6, *q*), while in this and another aperture a globo-stellate, from a compound tunicated animal, may be observed (fig. 6, *r r*). So there may not only be spicules of different sponges incepted, but a heterogeneous assemblage of all kinds of minute objects.

As regards the heterogeneous assemblage of minute crude material about the dried pseudopodia, the like may be observed to occur, for the most part, in the bodies of all the genera of Rhizopoda mentioned at the commencement of this communication, disappearing only in the frustules of the Diatomaceæ, where, however, there would still appear to be a "minute pore opening into the interior" of the "large granules," as on the surface of *Aulacodiscus formosus* noticed by Mr. Kitton (Monthly Microscop. Journ., June 1873, pl. xx. fig. 2), but which does not admit nourishment except under the most attenuated form.

Again, although the inception of heterogeneous material is evident in the Polytremata, it is not so in most of the other known Foraminifera; and the only species of Radiolaria in which (in the dead tests) I have seen it is a *Haliomma* shaped like a *gourde-de-pèlerin* (*Lagenaria*), dredged up plentifully with the sponge *Rossella* &c. in 300 fathoms, 74½° south lat.; so that this may have been a *post mortem* occurrence, although the contents closely resemble those of the Polytremata and those in the tests of living *Difflugia* and *Euglypha*.

Colour. Although I have never met with a colourless specimen of *Polytrema miniaceum*, or one that did not present the appearance of red or pink coral, especially after getting old, it is often accompanied by small patches of foraminated cells or chambers (varieties of our British species *Planorbulina vulgaris*), which as often present a light brick, roseate, or violaceous hue as they are absolutely colourless. Why the colour should be constant in *Polytrema miniaceum* and not so in these patches of cells, I am not able to explain; but among the sand accompanying the sponges dredged up on board H M.S. 'Porcupine' in the Atlantic Ocean, around the north of Ireland and Scotland respectively, it is not uncommon to find a Globigerine test (*Sphæroidina*?) presenting this colour, although I have never met with even a fragment from there of *Polytrema miniaceum*. The older the *Polytrema* appears to be, the deeper is the colour; and, as with the roseate patches of *Planorbulina*, the last-formed portions appear to be the lightest.

Thus *Polytrema miniaceum* externally differs from all other known Foraminifera in presenting a fixed, calcareous, arborescent test combined with a pink or crimson colour and superior apertures; while internally it differs from most Foraminifera in possessing a cancellous structure void of the canal-system, but permeated with cavernous excavations communicating with the apertures, and more or less filled with sponge-spicules and other foreign objects. The ovular and earliest stages of embryonic development I have not seen.

Having ground down a horizontal section of *Polytrema miniaceum* to extreme thinness and mounted it in balsam, I observe that the reticulated structure, together with the foraminated laminæ, which have become consolidated as already mentioned, is all pervaded by crooked, branched, anastomosing tubes, which appear to have been produced by the mycelium of a fungus or saprolegneous organism that pervades in like manner the old horny fibre of sponges and the reticulated calcareous structure of old coral, &c.

Polytrema balaniforme, Carter, 1876, = *Carpenteria*, Gray, 1858. Pl. XIII. figs. 7–10.

Test fixed, solitary or grouped (fig. 7). Composition calcareous. General form obtusely conical, open at the summit (fig. 7, *a a*), from which grooves descend in a somewhat gyrate direction to the circumference, so as to leave triangular interspaces which are slightly convex and, extending a little beyond the ends of the grooves, impart a lobed form to the circular base. Aperture single, at the summit (fig. 7, *a a*), spiral in form and smoothly marginate. Colour light grey. Surface uniformly even except where grooved, presenting a subhexagonal network of smooth depressed lines more or less covered by slightly convex foraminated interstices. Internal structure cancellous, like that of *Polytrema miniaceum*, laminate, excavated throughout by compressed triangular cavities sloping from the vertical axis of the cone to the circumference, defined by distinct septa or ridges laterally, supporting the foraminated lamina externally, while they rest on the preceding one internally, commencing in the cancellated structure of the circumference by gutter-like spaces separated by distinct septa like the foregoing, which diminish in number as the triangular cavity becomes narrowed upwards, until ceasing altogether it opens into the hollow central axis. Hollow axis commencing in a point at the centre of the base, and gradually increasing in size upwards till it reaches the aperture at the summit, spiral in form, and receiving the openings of the triangular cavities successively as it progresses upwards. Triangular cavities also commencing at the same point, increasing in size as they are successively formed between the layers of the spiral lamina, which, winding round the hollow axis and spreading out towards the base, at last ends in completing the evolution of the conical test; septa of the last-formed cavities corresponding with the grooves on the surface. Presenting, in horizontal sections at different distances from the base, subconcentric layers in a spiral form, diminishing in number upwards; and in a vertical section, the same in a conical form interrupted at the apices by the hollow columella. (For good illustrations of this generally, see Dr. Carpenter's figures alluded to in the "Explanation of the Plate.") Internal cavities lined throughout by a structureless sarcodic layer, which rests on the foramina of their walls, and on becoming dry assumes a brown colour and chitinous aspect; cavities more or less filled with different forms of siliceous sponge-spicules, entire and fragmentary, together with grains of sand (chiefly calcareous) and other minute objects, agglutinated into a mass by a sarcodic (?) substance, which when dry presents a dark brown colour. Test generally more or less transfixed by siliceous sponge-spicules entire and fragmentary, which become incorporated with the calcareous material during its formation. Size about 9-24ths inch in diameter at the base by 1-12th inch high.

Hab. Marine, on the valves of *Mytilicardia calyculata* and other hard objects, *Pecten*, *Porites*, &c. (*Carpenter*).

Loc. West Indies? Indian Ocean (*Carpenter*).

Obs. Although the form and colour of *Polytrema balaniforme* are specifically different from those of *P. miniaceum*, the structure generically is the same; that is, the subhexagonal reticulation with foraminated interstices of the spiral layer, giving in the horizontal and vertical sections subconcentric and conical layers respectively, are *mutatis mutandis* the same; while the cancellated structure generally and the large internal cavities containing more or less siliceous sponge-spicules and other minute foreign objects, together with a *superior* opening, are, but for their much larger size in *P. balaniforme* (bearing the proportion of eight to one), almost identical—even to the absence of the canal-system, which Dr. Carpenter unintentionally confirms where he states respecting this system that "the two layers [of the approximated chambers] sometimes separate from each other, as shown in the figures, so as to leave intraseptal spaces; and these form a tolerably regular canal-system, which may be traced throughout the network of ridges that covers the inner wall of each principal chamber," &c. (Introd. p. 188). Now as the canal-system of a Foraminiferal test is formed of distinct calcareous tubes, through which the sarcode creeps *within* the intraseptal spaces, it is evident that on canal-system was present in this instance, any more than in *Polytrema miniaceum*, where the only network in the interspaces between the chambers appears to me to be that which I have described in *P. miniaceum* as the centre of the lines forming the subhexagonal structure on the surface of the older test (Pl. XIII. fig. 6, *l*), well represented by Max Schultze in his figure of an "Acervuline *Planorbulina*" copied into Carpenter's 'Introduction' (pl. xiii. fig. 1). So this interseptal space must be something else.

Perhaps the chief point of difference between *P. balaniforme* and *P. miniaceum* is that the hollow pillars supporting the concentric foraminated (spiral ?) layers in the latter are represented by solid ridges of test-material in the former, which, radiating *continuously* downwards from the hollow vertical columella as the layers of the spiral lamina increase, give rise to the form and direction of the triangular cavities, which, subdivided by subordinate septa of the same kind, distinctly represent the chambers of a foraminiferal test. Whether the ridges of solid structure have been solid from the commencement, or, like the pillars of *P. miniaceum*, were hollow first and then became solid afterwards, my specimens of *P. balaniforme*, as they are all full-grown, do not enable me to determine.

Furthermore, it is remarkable that, although Dr. Carpenter in his 'Introduction' frequently compares *Polytrema* with *Carpenteria*, he never once mentions *Polytrema* in his generally excellent description and illustrations of *Carpenteria*; while in reference to Dr. Gray's suggestion "that *Polytrema* might be especially related to *Carpenteria*," Dr. Carpenter observes it is "an idea which is not confirmed by examination of the internal structure of those types" (Introd. p. 235). That, however, Dr. Gray was right may be gathered from my descriptions of *Polytrema miniaceum* and *P. balaniforme* respectively.

But when we come to the following passage respecting the presence of sponge-spicules in *Carpenteria* and not in *Polytrema*, viz. "it is a fact of some importance with regard to the presumed spongeous character of the body of *Carpenteria*, that, although (as will be presently seen) the openings at the extremities of the branches of *Polytrema* communicate very freely with the chambered interior, I have not been able to find the least trace of the spongy parasite in its substance" (*op. cit.* p. 236), we not only realize the force of Max Schultze's observation before quoted ('Annals,' 1863, vol. xii. p. 419), viz. that "by this means Carpenter establishes a sharp distinction between *Polytrema* and *Carpenteria*," but that this arose from Carpenter's specimens of *Polytrema*, according to Max Schultze, having contained "no spicules in their interior." How this could be I know not, seeing that the specimens of *Polytrema* which Dr. Carpenter gave me did, as I have stated, contain spicules in their interior ('Annals,' 1870, vol. v. p. 391).

Lastly, Dr. Carpenter observes (for he is the only authority on this subject), "it is not a little curious that there should be a strong external resemblance between *Polytrema* and some of the less regular forms of *Carpenteria*—a resemblance which is increased by the presence of free openings at the extremities of the branches in the former, and by the precise conformity which its areolation often presents to that of *Carpenteria*. The relation, however, is one of mere isomorphism, as we have seen the internal structure of the two organisms to be essentially different" (*op. cit.* p. 237). To me the "internal structure" is, *mutatis mutandis*, "essentially" the same.

Possessing a view so totally different from that of Dr. Carpenter with respect to *Polytrema* and *Carpenteria*, and so opposed to the suggested hybrid nature of the latter, to which the former must be now added as equally containing sponge-spicules in its internal cavities, and therefore equally presenting a form half foraminiferous and half spongeous, it may not be considered useless to endeavour to get rid of this mythical impression altogether by substituting Risso's generic name of "*Polytrema*" for Gray's "*Carpenteria*," and qualifying it by the significant designation of *balaniforme*, in accordance with Dr. Carpenter's well suggested resemblance of the latter to *Balanus*, with which no doubt it has often been confounded.

When writing on the species of Foraminifera which I termed *Conulites Cooki*, Dr. Carpenter states, "The fossil described by Mr. Carter under the new generic name of *Conulites* does not appear to me to differ so essentially from the preceding in general plan of structure as to require being generically separated from it;" and thus my *Conulites* was changed to "*Patellina Cooki*" (*op. cit.* p. 233). I might say the same with reference to *Carpenteria*, had I not stronger grounds to go upon than Dr. Carpenter seems to me to have had in changing my name of *Conulites* to *Patellina*.

Again, when I discovered that the organism which Dr. Bowerbank had placed, and still continues to place, among the British sponges under the name of "*Halyphysema Tumanowiczii*" (Mon. Brit. Spong. vol. ii. 1864, and vol. iii. 1873, pl. xiii.) was not a sponge but a foraminiferous animal, and published an illustrated description of it ('Annals,' 1870, vol. v.

p. 311, pl. iv.), which I believe all have accepted except Dr. Bowerbank and Prof. Häckel ('Die Kalkschwämme,' 1872, vol. i. p. 456, footnote), I considered the myth so great that, to do away with the impression here also, I gave it Max Schultze's generic name of *Squamulina*, seeing that its foot or base of attachment consisted of a submultilocular test of this (Rotaline) kind, while the superstructure which grows from the summit of the test, resembling a little brush, was specifically designated "*scopula*"—the internal sarcodic contents and the peculiar form presented by the extended pseudopodia during active life being identical with that of a foraminiferous animal. Now Häckel regards it as a "polyp, which he names *Gastrophysema*" (!) (*ap.* Lankester, 'Quart. Journ. Micr. Sci.' Jan. 1876, p. 57). It is useless to criticise such vacillation.

When, again, the late Dr. Gray gave the name of "*Carteria*" to the spongeous head of *Hyalonema Sieboldii*, under the idea that the latter was a parasitic sponge developed upon the extremity of a glassy cord produced by a polype (Proc. Zool. Soc. 1867, p. 540), I tacitly rejected the myth by not adopting it.

And now for similar reasons I propose to do away with Dr. Gray's name of *Carpenteria* by substituting for it Risso's generic one of *Polytrema*, thereby hoping to get rid *entirely* of the mythical impression conveyed by the former, which has hitherto been that it represents a hybrid, half foraminifer, half sponge.

As has been above stated, there is a sharp line of distinction between the Foraminifera and the Sponges, even if we had not the presence of the spongozoon in the latter to confirm this; but with the latter it is impossible to confound sponges with any of the Rhizopoda, all of which, viz. *Arcella*, *Difflugia*, *Trinema*, *Euglypha*, *Gromia*, together with the Foraminifera and the species of Radiolaria (*Haliomma*, vide p. 197) that I have examined, respectively possess within their test a sarcodic animal substance like that of *Amœba*, which, issuing after the manner of pseudopodia from one or more apertures of the test, and drawing in crude food thereby, whose *egesta* are discharged through the *same* orifices, possess but *one* course for both, like *Actinia* and the polyps generally; while sponges, possessing *two* courses and two kinds of apertures, viz. one for taking in crude food and another for discharging the *egesta*, which is effected by groups of distinct animals (the spongozoa) imbedded in the sponge-structure, are more like the Compound Tunicata in this respect. Hence I have long since stated ('Annals,' 1873, vol. xii. pp. 27, 28) that the "embryos" of some of the Compound Tunicata, as seen in the gelatinous mass, "have very much the appearance of what is seen in *Halisarca guttula*, and if arrested in this stage of development would be almost identical; but when the cell-mass of the embryo is 'told off' into the organs which they are to assume in the fully developed Ascidian, then of course the difference at once becomes obvious."

This view has been opposed with no small amount of acrimony by Prof. A. Giard, of Lille, who published his "Recherches sur les Synascidiés" (Compound Tunicata) in the first volume of Lacaze-Duthiers's 'Archives de Zool. expérimentale et générale,' and in the second volume (viz. that for 1873, p. 481) dwells on what he considers to be the resemblance between the "Myxospongiaires et des Synascidiés," viz. "mimétisme," whence he suggests for a supposed new species of *Halisarca* the name of *H. mimosa*. Now, it being a matter of opinion whether my likening the embryo of some of the Compound Tunicata to that of the Halisarcida, as above mentioned, is in favour of the "theory of evolution" or that of "mimicry," the question is not worth disputing; "*le jeu ne vaut pas la chandelle.*" But when Prof. Giard comes to translate my words above mentioned, viz. "almost identical" into "Il y a identité complète" (*op. et tom. cit.* p. 490), it is very evident that it is *not* a matter of opinion whether he has or has not falsified my assertion; it may, however, be still a matter of opinion whether Prof. Giard can or cannot read English; and so far it would be only charitable to assume the former. But still the fact remains to cast a doubt unfortunately over the rest of his statements—a doubt which, considering their apparent value, I would most willingly have not entertained.

Returning now to *Polytrema balaniforme*, we observe that the most striking feature, next to its form, is the coarseness of its structure, not only when compared with that of *Polytrema miniaceum*, but with that of all the other large Foraminifera known, together with the comparatively enormous size of its internal cavities and the quantity of sponge-spicules, both entire and fragmentary, agglutinated together in massive accumulation, that they contain. Having had to truncate one of my specimens for structural examination, several fragments of the sponge-spicule accumulations fell out, which, on being decalcified by the aid of dilute nitric acid and mounted, gave almost innumerable forms, one of which (viz. a bihamate, with a serrated crest of recurved spines extending some way backwards on the outer side of each extremity?) is quite new to me (fig. 10). It gave me also the opportunity of examining the calcareous portions under a higher power (viz. $\frac{1}{4}$-inch object-glass), which were thus found to have incorporated so many spicules, both entire and fragmentary, as to lead to the idea that the latter had been turned to account for strengthening the structure of the test generally.

Propagation. The circumferential cavities near the base in two of my specimens having been broken open, presented in one instance a great number of free, white, crystalline rough globules of different sizes below the 1000th of an inch in diameter, which, under the magnifying-power just mentioned, showed a radiated structure like those in some of the Compound Tunicata, to which they no doubt belong; while the radii in the fully developed ones being ovoid acuminated, with the sharp end towards the centre, gives a form which cannot be identified with any figured by Prof. Giard (*loc. cit.* pl. xxii.), nor with any that I have found on the south coast of Devon. How these have come where they now are (that is, whether they have been developed there by an embryo of one of the Compound Tunicata, or drawn in by the pseudopodia of the *Polytrema*), I have not means of determining. But at first they looked so much like the oviform bodies common to the chambers of the Foraminifera, while they are so far removed from the large cavities containing the spicules, that, had I not known the ova of Foraminifera to be soft, nucleated, and of a yellowish colour, the white frosted appearance of these globules might not have led to that examination which proved them to belong to one of the Compound Tunicata.

In the other instance the cavities broken open contained several *fixed*, circular, obtusely conical bodies of a yellowish colour, scattered over their surfaces (Pl. XIII. fig. 9, *a b*), and varying in size below the 332nd part of an inch in diameter both in breadth and height, the largest of which *in situ* (when viewed by *reflected* light) presents a lobed form with a dark point in the summit, something like a hole (fig. 9, *a*). The smaller ones (fig. 9, *b b b*) are *not* lobed, but, when mounted *in situ* (that is, on a fragment of the test, fig. 9), and viewed with a high power by *transmitted* light, present a minutely corrugated transparent envelope more or less filled with minute, granular, opaque material, also furnished with a dark point like an aperture at the summit. Whether the "lobed" larger ones are or are not a more developed state of the unlobed smaller ones, or whether or not they are all the same, and all embryos of *Polytrema balaniforme*, there is nothing to determine beyond what has been mentioned, and that for the most part they are based on one or two spicules adherent to the surface of the cavity of the test in which they are situated.

Lastly, a single embryo (fig. 8) was found *outside* the test of one of my specimens, close to its circumference, on the shell of the bivalve to which it had adhered, and had become developed under the protection of a projecting lamina of the shell. This, which is conical and, when first examined *in situ*, upright, presented a single large aperture of a *spiral form* in the summit, was afterwards removed by a hair pencil and mounted in balsam, where, falling on its side, the aperture of course became undistinguishable, while the body generally presented an elongated conical form about 1-92nd inch long, and 1-138th inch broad at the base (fig. 8).

On examining this with a ¼-inch object-glass and transmitted light, it appears to consist of a transparent yellowish envelope of a chitinous aspect (fig. 8, *c*), in the interior of which is a cylindrical conical cavity extending downwards from the aperture at the summit to near the bottom of the base, surrounded throughout by minute granular opaque material (fig. 8, *g*).

The envelope (fig. 8, *c*) is very irregular in its outline, and, besides the large aperture at the summit (fig. 8, *a*), presents an appearance of several smaller ones on the sides at the ends of conical or wart-like processes respectively (fig. 8, *e e*), *out of one of which projects a minute filament of probably foreign material* (fig. 8, *f*). At the base it is spread out irregularly, being deflected or prolonged in one direction much more than in any other (fig. 8, *b*), while its surface is microscopically granulated throughout, barely visible with the power mentioned.

The cavity (fig. 8, *g*) is, as before stated, cylindrical, apparently corrugated in a spiral manner at its upper part, widest where it ends in the aperture at the summit, and narrowed to a point at the other extremity, where it appears to be turned towards the deflection of the base.

Lastly, the minute granular opaque material which surrounds the cavity appears to be arranged in pouch-like aggregations.

Thus the embryo of *Polytrema balaniforme* (= *Carpenteria*), if this be one (and there does not appear to me to be any reasonable doubt on the subject), does not begin in the form of a "Globigerine type of Foraminifera" approximating "closest to *Rotalia*," as stated by Dr. Carpenter (*op. cit.* p. 188), unless the *lobed* form of the supposed embryos in the broken chambers above mentioned be considered as such; but then the smaller ones, which have been viewed as the preceding stage of development, are *unlobed*, and all have the apparent aperture *superior* and *apical* as in *P. balaniforme*, not inferior and basal as in Rotalina. In short, we do not yet know the embryonic form which the ovum of either *Polytrema balaniforme* or *P. miniaceum* first takes, any more than we know the form of the ovum itself. The latter is probably spherical, as in most other Foraminifera; and its earliest embryonic form may also be a spherical cell, as in *Nummulites* &c. ('Annals,' 1861, vol. viii. pl. xvii. figs. 2 *o*, 12 *e*, & 15 *e*); but in the thin Australian *Orbitolites*, of which I have several specimens in which the chambers are charged with embryos, the latter are all *elliptical* elongate.

It is true that in the supposed embryos of the broken chamber in *Polytrema balaniforme* we have a conical fixed form, consisting of a corrugated transparent envelope enclosing minute-granular opaque material, and the appearance of an apical aperture—all of which is found in the single embryo developed just outside the test; yet the more advanced state of the latter and the differentiation of parts, with *the presence of a filament of foreign material projecting from one of its apertures* (fig. 8, *f*), is much more suggestive of *its* real nature than that of the "embryos in the broken chambers."

Finally, the presence of more than one aperture about the envelope of the single embryo seems to point out that in the fully developed test there may be also more than one, through which the sponge-spicules &c. are drawn into the interior—a fact which the projecting of spicules through certain portions of the surface of the full-grown test seems to indicate, although it is impossible to state this with certainty, from the rough treatment to which my specimens have been subjected having caused a great part of their foraminated areæ to be irregularly broken out. Such apertures would of course be subsidiary, and formed, as they are in *Polytrema miniaceum*, by an accidental destruction here and there of one of the foraminated interstices of the network on the surface.

Not possessing more than full-grown specimens of *Polytrema balaniforme* (fig. 7) and the early embryonic form above described (fig. 8), I have no means of following its gradationary development further than is indicated by the structure itself of the former, which is above given.

Note on Parkeria.

Through the kindness of Mr. W. J. Sollas, I became possessed of a spheroidal specimen of *Parkeria*, $1\frac{1}{2}$ inch in diameter, from the neighbourhood of Cambridge, on the 1st of February, some days after my MS. on the Polytremata had been sent to the press. This specimen, when it reached me, was in three pieces, consisting of the two halves of the sphere *minus* an entire central slice, which had been ground down to great thinness and mounted for microscopical examination. Most of the cavities, originally in the interior, had become filled with calcspar; and the rest were empty. When entire, the whole consisted of a spheroidal mass of reticulated structure, with rough papillated exterior, traversed by a large axial space in the form of an elongated cone, whose point, situated close to the circumference on one, extended to the base which occupied a portion of the circumference of the other side. This elongated cone, which attains in the centre a diameter of one third of an inch, and presents an irregularly scalloped line on the *surface* in the section, diminishes slightly towards the base, and is surrounded on all sides, except the extremities, by concentric layers of chambers ("chamberlets," Carpenter, Phil. Trans. 1869, vol. clix. pt. 2, p. 728), also excavated in the reticulated structure, each chamber being more or less irregularly quadrangular, representing in miniature a *crypt* arising from four columns, whose pillars and arches are formed by the reticulated structure; while all the chambers or "crypts," being piled one upon another in radiating columns, undergo division successively as they extend outwards from the cone, so as to fill the spaces that would otherwise be left towards the circumference, since the chambers, although very irregular in shape, are much the same in size throughout. Hence, when a longitudinal section is made through the centre of the conical space, the reticulated structure is also observed to be in radiating columns, which present a series of floral-like expansions as they successively follow each other in forming the columns of support to the arches of the cryptiform chambers respectively.

As there is an irregularly reticulated structure, so there must be the same form or kind of continuous interstices; and this has been termed by Dr. Carpenter the "labyrinthic system" (*tom. cit.* p. 729); besides which, this labyrinthic system opens into larger spaces of a short cylindrical form, which chiefly occupy the pillars of the crypt-like chambers, and thus possess a more or less radial direction, although they are by no means more continuous or regular in position than those of *Polytrema miniaceum* above mentioned. These are the "radiating tubes" of Dr. Carpenter (*tom. cit.* p. 728).

In consequence of the axial conical space in my specimen being distinguished from the rest of the structure by the presence of a heterogeneous mass of foreign material, among which may be observed innumerable fragments of sponge-spicules and minute Foraminifera, while this is limited in one direction by the closed conical end, and continued to the surface of the test at the other or basal extremity of the axial space, it seems that the latter was the direction of the main inlet, however much (where empty, as in Dr. Carpenter's specimens) it may be divided into chambers by septal partitions. In short, the space was conical with the base open, and so far like the conical axial cavity of *Polytrema balaniforme*, if not also sometimes "spiral" (*tom. cit.* p. 728, footnote).

When we come to the cavities of the test outside the cone, we find that those of the chambers ("chamberlets") and those of the interstices of the reticulated structure ("labyrinthic system"), including the "radiating tubes," are empty in some and filled up by colourless transparent calcspar in other parts.

Of what, then, was the fibre of the reticulated structure composed? for the whole test was formed of it.

That *Parkeria* was a species of Foraminifera can hardly be doubted; but one of the chief characters of the Foraminifera is their foraminated areæ, of which the so-called "nummuline tubulation" is an example; and the existence of this in *Parkeria* has hitherto not been demonstrated.

Now this structure, which fills the interstices of the reticulation in *Polytrema miniaceum* as well as in *P. balaniforme*, is so thin that it is often broken away, and moreover, with the exception of the surface, often disappears altogether in *P. miniaceum*, as I have above stated, leaving a simple mass of reticulated fibre in the interior, which, under these circumstances, becomes analogous to that of *Parkeria*.

Thus, if we suppose the reticulated fibre of *Polytrema miniaceum* to have been converted by fossilization into calcspar, and coated with a granular crystallization of a yellowish calcareous material, we should have the same composition as that which appears to me to exist in the fibre of *Parkeria*. Or the reticulated fibre of *Parkeria* might have been always hollow, as the radiating pillars in the *young* test of *Polytrema miniaceum*, which here, however, afterwards become solidified, also as above stated, in which case the *coating* might originally have been organic.

Be this as it may, one object in introducing *Parkeria* here (which otherwise appears to have been so well described and illustrated by Dr. Carpenter, *loc. cit.*) is to state that the coating on the surface of the reticulated fibre of this fossil appears to me *not* to be composed of "sand," but of a granular crystallization of calcareous material.

My attention was first called to this by observing that in the composition of the fossilized test of *Parkeria* there were only nine parts of silex in a hundred, the rest being chiefly calcareous material, also that in some parts, according to Dr. Carpenter (*tom. cit.* p. 732), the angular sand-grains were fitted together with "marvellous exactness," and that in my section of the Kelat fossil (*Alveolina meandrina*), to which I have above alluded as closely allied to Mr. Brady's description and illustrations of *Loftusia*, there was *no* appearance of sand-grains; I therefore became suspicious of the so-called "arenaceous" composition. Hence I examined my specimen of *Parkeria* with this view, and find that the *fibre* of the reticulated structure is composed of transparant colourless calcspar, covered with a rough or frosted yellowish granular coat of calcareous material, more or less filling up in larger crystallization of the same form some parts of the labyrinthic interstices (much as stalactite in a limestone cavern, &c.). I therefore infer that the original fibre is represented by the calcspar, and that the granular coating has been added during fossilization. Had the latter been siliceous instead of calcareous, it would probably have presented the usual smooth, or at least prismatoid, granular appearance of botryoidal chalcedony, instead of the rough rhombohedral granulation of a calcareous base; so that the "sand-grains" so well represented by Dr. Carpenter in the siliceously infiltrated specimen (*tom. cit.* pl. lxxvi. fig. 1), if also composed of silex like that of the infiltration, should, it seems to me, be viewed as a siliceous pseudomorph of calcareous crystallization.

It is almost impossible to conceive a hard, sharp, granular, angulated surface in *any* organic cavity where the soft parts in contact with it are in continual motion, as it seems impossible to confound the heterogeneous sand-agglomeration so often witnessed in Foraminiferal tests with the uniformity of this mineral crystallization. In a specimen of *Lituola nautiloidea*, Lam. (*canariensis*, D'Orb., mihi), about one sixth of an inch in its greatest diameter, this contrast is most obvious; while the "labyrinthic" structure is cancellous laminar, like that of bones, and not composed of reticulated *fibre* like that of plants and *Parkeria*. In *Lituola* the labyrinthic structure is excavated *in* the test; in *Parkeria* the reticulated fibre, in which the "labyrinthic system" is, *is the test itself*.

I have alluded to the absence of the foraminated areæ; but I think I can see one of these on the border of the "conical space" in my mounted section, in which the foramina and their regularity in size (1-1800th inch in diameter) and position are almost identical with those in the interstices of the reticulated structure of *Polytrema balaniforme*, and therefore much smaller and more regular than any thing of the kind presented by the reticulated structure generally of *Parkeria*: hence the openings of the labyrinthic system, as this structure was successively formed on the surface of the concentric layers of the test, may have thus been faced with a foraminated lamina, like the interstices of the reticulated structure forming the concentric or successive layers of *Polytrema miniaceum* and *P. balaniforme* respectively.

Polytrema utriculare, n. sp. Pl. XIII. figs. 11–16.

Test fixed, calcareous, colourless or whitish grey, gregarious. General form globular, bottle- or sac-shaped (figs. 11–14), with the aperture generally single and more or less superior (fig. 12, *b b b*), supported on a short neck, rounded and inflated at the margin and expanded at the base, where it becomes continuous with the bottle-shaped body (fig. 13, *a a a*). Surface cribriform, commencing a short distance from the neck in a subhexagonal bee's-comb-like network, so much in relief that the foramina which fill the interstices at the bottom can hardly be seen except by direct view (figs. 12 & 15). Internal structure consisting of a large, single, unseptate, globular cavity, corresponding with the external form, and surrounded on all sides but the base by the cribriform structure mentioned (fig. 15), which, when viewed in a vertical section, shows that the bee's-comb-like network (figs. 15, *a*, & 16, *a*) rests upon the foraminated layer (figs. 15, *b*, & 16, *b*) in the proportion of two to one, the whole being 3-830ths of an inch in thickness. Cavity lined by a sarcodic layer of a chitinous aspect when dry (fig. 14, *e*), open at the aperture and closed below, where it forms the bottom of the sac-like or bottle-shaped body, which is thus attached to the object on which the species may be growing. Filled more or less with siliceous sponge-spicules and calcareous grains of sand, which, together with other minute objects, are agglutinated by sarcode into a mass that presents a yellowish or dark-brown amber-colour when dry (fig. 14, *b*). Size variable, as the sac-like body varies in form: body of the most regularly formed specimen that I possess about 1-24th inch in diameter, and about the same high, including the neck and aperture.

Hab. Marine. On hard objects (old coral &c.).

Loc. Tropics?

Obs. The utricular body of this species is subject to great variety in form, owing to the various influences that may affect it during growth. When on a free surface, however, it is generally bottle-shaped, globular, with superior aperture. Sometimes the latter is double, as may be seen by the illustration, wherein there are four apertures and only three chambers (fig. 12, *b b b b*). The single unseptate chamber and the prominence of the *reticulated structure* on the surface are sufficient to distinguish it from the foregoing species; while the calcareous composition, *superior* aperture, reticulated surface, with foraminated interstices, and heterogeneous spicular contents of the cavity sufficiently ally it to them to justify its being considered a *Polytrema*. It might be viewed as a transition form between *Polytrema* and *Planorbulina*, but can never be considered a species of the latter, being more like the "rough" *Globigerina*, in which there is a reticulated surface but *only one* foramen at the bottom of each interstice.

Filling up the crevices in the groups of *Polytrema utriculare* is a new species of *Pachastrella* (sponge), which I would propose to designate "*parasitica*," whose skeleton-spicule (fig. 17, *a*) consists of a simple short shaft terminated by three arms, each of which is twice furcated, together with a minute flesh-spicule (fig. 17, *b*) formed of a bacillary shaft like that of *Dercitus niger*, but longer and more thickly and minutely spined. It is the habit of *Pachastrella* to creep into such recesses, and thus to follow closely upon the borings of a *Cliona*; so that in one instance I found *Dercitus niger* together with a *Cliona* in the midst of a thick piece of branched coral which came from Cuba.

Polytrema planum, n. sp. Pl. XIII. figs. 18 & 19.

Test sessile, calcareous, solitary, colourless. General form thin, flat, frondaceous, following in shape the surface on which it may be growing (fig. 18, *b*). Surface even, smooth, tesselated by a polygonal reticulation with foraminated interstices of various shapes (fig. 19); margin irregular; aperture excentric, circular in form, with raised thin margin (fig. 18, *c*). Internal structure cancellous, one layer deep, corresponding with the reticulation on the surface. Chambers or flat cancelli sacciform or utricular at the margin. Contents of the cells sarcodic. Size $\frac{1}{4}$ of an inch in diameter, almost immeasurably thin.

Hab. Marine. On hard bodies (old coral, &c.), spreading *Melobesia*-like, following in form that of the surface on which it grows.

Loc. Australia.

Obs. I have but one specimen of the species, which is on a branch of old coral partly overgrown with *Melobesia* and other algæ, sponge, &c., bearing *Orbitolites*, *Polytrema miniaceum*, and almost every variety of *Planorbulina vulgaris*, together with *Alveolaria* and other minute forms of free Foraminifera. The even reticulation with foraminated interstices hardly raised above the surface, accompanied beneath apparently by a more or less continuous internal cavity, although very thin, with superior aperture, allies this Foraminiferous test much more to *Polytrema* than to *Planorbulina*, although its marginal cells very much resemble those of the latter. Having only one specimen, and not liking to destroy any part of it, what I have stated concerning the "single" aperture (fig. 18, *c*) and "continuous" internal cavity must be considered provisional. The latter may be in chambers corresponding with the reticulation on the surface, and therefore divided; or it may be supported by pillars, as in *Polytrema miniaceum*, and thus more or less continuous.

On the surface of the specimen is a small group of pink *Planorbulina*-utricles (fig. 18, *d*), which in their form and much larger size, together with their foramina, contrast strongly with that of *Polytrema planum*. I have also specimens of *Polytrema miniaceum* respectively growing upon colourless patches of *Planorbulina*, but never saw *Planorbuliua* either colourless or pink growing by the combination of its utricular cells, or in any other way, into the form of *Polytrema miniaceum*; hence I agree with Dr. Carpenter (*op. cit.* p. 209) that Max Schultze's Acervulinida are nothing else but pink varieties of *Planorbulina* (Max Schultze, 'Polythalamien,' 1854, p. 67, pl. xvii. figs. 12–15).

EXPLANATION OF PLATE XIII.

Fig. 1. *Polytrema miniaceum*, De Blainville, nat. size.

Fig. 2. The same. Central portion of basal layer, about 2-48ths inch in diameter, viewed from the outside, showing:—*a*, confused arrangement of primary chambers; *b*, three circular rows of radiating lines with oblong quadrangular interspaces; *c*, portion of basal layer reflected, to show foraminated roof of circular cavity. Scale 1-96th to 1-830th of an inch.

Fig. 3. The same. Diagram of horizontal section of fragment, to show relative position of foraminated (="spiral") layers, *a a a*, and *hollow* pillars of support, *b b b*.

Fig. 4. The same. Embryonic form, nearly 1-80th inch in diameter at the base and 1-83rd inch high, broken out at the side, showing:—*a*, base expanded and foraminated; *b*, cylindrical stem or process, also foraminated; *c c*, broken edges of foraminated layer; *d*, thin superior or growing portion of the same; *e*, cancellated structure of interior; *f*, siliceous spicules of sponges projecting from the interior. Scale 1-12th to 1-830th of an inch.

Fig. 5. The same. Truncated end of embryonic form, on the same scale, just where the cancellated structure commences, showing the relative position, number, and size of the cavities at this point.

Fig. 6. The same. Diagram of head, to illustrate description: *a a a*, branches entire; *b b*, ends of branches broken off; *c c c*, apertures of entire branches; *d d*, external or foraminated surface; *e*, internal structure; *f f f*, young foraminated layer; *g g g*, dimples or ends of pillars of support in foraminated groundwork; *h h*, unforaminated linear areæ uniting the same; *i*, larger dimples or circular areæ, foraminated in the centre and surrounded by an unforaminated ring; *k*, subhexagonal or polygonal unforaminated reticulation, with foraminated interstices; *l*, fine linear (tubular?) network in centre of unforaminated reticulation; *m m m*, threads composed of an agglomeration of sand, siliceous spicules, and other minute objects, connected with the apertures and with each other; *n n n*, spicules projecting from the apertures of the entire branches; *o o o*, the same, projecting from apertures formed in the ends of the branches broken off; *p*, triradiate spicule arrested in an aperture; *q*, purple spicule of a *Gorgonia*; *r r*, globo-stellates of a Compound Tunicated animal; *s s*, dried pseudopodia; *t t*, cancellated structure of interior; *v v v*, cavities in the same, containing spicules chiefly in a fragmentary condition.

Fig. 7. *Polytrema balaniforme*, Carter (*Carpenteria*, Gray), on a valve of *Mytilicardia calyculata*, nat. size: *a*, *a*, apertures.

N.B. For good illustrations of the test of this species, see Carpenter, 'Phil. Trans.' 1860, vol. cl. pt. 2, pl. xxii. figs. 1 and 5–15; also 'Introduction to the Study of the Foraminifera,' 1862, pl. xxi. figs. 6–18, but not so well executed.

Fig. 8. The same. Supposed embryo, about 1-92nd inch long: *a*, apex; *b*, base; *c*, chitinous integument, micro-granulated; *d*, large spiral aperture; *e e*, small papillary apertures; *f*, one of same, from which a minute filament of foreign substance is projecting; *g*, internal cavity, surrounded by opaque granular material, apparently in pouch-like cavities. Scale about 1-12th to 1-830th of an inch.

Fig. 9. The same, embryos of (?), on fragment of cancellated cavity from near circumference: *a*, lobed form, 1-332nd inch in diameter; *b b b*, unlobed smaller forms. Scale 1-12th to 1-830th of an inch.

Fig. 10. The same. Sponge-spicule; new form of bihamate or fibula, from among spicules of the interior, 1-250th inch long. Lower end restored.

Fig. 11. *Polytrema utriculare*, n. sp., group of three individuals, nat. size.

Fig. 12. The same, superior view, magnified: *a*, utricular bodies; *b b b*, apertures; *c*, polygonal reticulation of surface.

Fig. 13. The same, lateral view, magnified: *a a a*, apertures at the ends of neck-like prolongations of the tests respectively.

Fig. 14. The same, basal view, from which the sarcodic (now chitinous) layer at once of occlusion and attachment has been removed, showing:—*a a a*, cavities of the three individuals respectively, each of which is filled with fragments of spicules, as represented in *b*; *c*, wall at base of test, showing relative position and size of polygonal reticulation and foraminated layers respectively; *d*, apertures on internal aspect of foraminated layer; *e*, sarcodic (now chitinous) layer lining the utricular chamber and prolonged into the aperture—reflected.

Fig. 15. The same, fragment of surface, magnified, to show, *a*, polygonal reticulation, and, *b*, foramina at the bottom of the interstices respectively.

Fig. 16. The same, vertical section of wall of test, to show relative position and size of polygonal reticulation, *a*, and foraminated layer, *b*.

Fig. 17. Siliceous sponge-spicules characteristic of a *Pachastrella* growing over some of the groups of *Polytrema utriculare*—*Pachastrella parasitica*, n. sp.: *a*, skeleton-spicule spreading into a head 40-6000ths inch in diameter; *b*, flesh-spicule, 5-6000ths inch long.

Fig. 18. *Polytrema planum*, n. sp., nat. size, on a branch of coral: *a*, coral; *b*, *Polytrema*; *c*, its aperture; *d*, group of *Planorbulina vulgaris*.

Fig. 19. The same, diagram of a few of the chambers, magnified, to show their variety in form, also foramination and stoloniferous intercommunications.

XX.—*On a new Species of* Coris *from the Molucca Archipelago.* By Dr. A. A. W. Hubrecht, Conservator at the Leyden Museum.

This species (a specimen of which was among a collection of fishes from the island of Ceram, sent by Mr. Lüdeking) may be distinguished at a glance from any of the known species of the genus by the oblong transverse pearl-coloured spot which descends from between the fourth and seventh dorsal rays. Another feature by which it may be easily distinguished is the (apparently) blue band running from the lips along the throat to the ventrals. The back is crossed by numerous transverse bands, darker than the ground-colour, broader than the interspaces, and not continued on the belly. The lower half of the dorsal fin is dark-coloured, the upper half light; both it and the anal fin have a thin dark-coloured streak running close along the outer margin.

I have named it after Dr. Bleeker, who has introduced into science such a considerable number of new fishes from the archipelago already.

Coris Bleekeri, sp. nov.

D. $2+\frac{7}{12}$. A. 3 | 12. C. 1 | 12 | 1. P. 2 | 11. V. 1 | 5.

C. corpore oblongo compresso, altitudine 4 circiter in ejus longitudine, latitudine $2\frac{1}{3}$ ad $2\frac{1}{2}$ circiter in ejus altitudine, capite acutiusculo 4 ad $4\frac{1}{4}$ circiter in longitudine corporis; altitudine capitis $1\frac{2}{5}$ circiter in ejus longitudine; oculi diametro $5\frac{3}{4}$ fere ad 6 in longitudine capitis; oculis diametro $1\frac{1}{2}$ distantibus, diametro $\frac{1}{2}$ ad $\frac{3}{4}$ a linea rostro-frontali remotis, linea rostro-frontali declivi convexiuscula vel rectiuscula; labiis carnosis; maxillis subæqualibus, superiore ante oculum desinente $4\frac{3}{4}$ circiter in longitudine capitis; dentibus maxillaribus biseriatis, intracristalibus graniformibus minimis, cristalibus conicis acutis, anticis 2 caninis mediocribus curvatis prominentibus; angulo oris dente prominente nullo; squamis lateribus 76 circiter in linea laterali absque caudalibus minimis: linea